DOT/FAA/RD-90/19

Research and Development Service
Washington, D.C. 20591

Rotorcraft En Route ATC Route Standards

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August 1991

Final Report

This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

U.S. Department of Transportation

Federal Aviation Administration

NOTICE

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/RD-90/19		

4. Title and Subtitle Rotorcraft En Route ATC Route Standards	5. Report Date August 1991
	6. Performing Organization Code
7. Author (s) Raymond H. Matthews, Brian M. Sawyer	8. Performing Organization Report No. 90-RR67
9. Performing Organization Name and Address Systems Control Technology, Inc. 1611 North Kent Street, Suite 910 Arlington, Virginia 22209	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DTFA01-87-C-00014
12. Sponsoring Agency Name and Address U.S. Department of Transportation Federal Aviation Administration 800 Independence Avenue, S.W. Washington, D.C. 20591	13. Type Report and Period Covered Final Report
	14. Sponsoring Agency Code ARD - 30, ATR - 100

15. Supplementary Notes

ARD - 30 Vertical Flight Special Program Office
ATR - 100 AT Systems Plans and Programs Division

16. Abstract

This report identifies constraints on helicopter operations in the en route environment as they relate to visual flight rules (VFR), special visual flight rules (SVFR), and instrument flight rules (IFR). However, since there is relatively little VFR/SVFR interaction between helicopters in the en route environment, the report concentrates on IFR operations and recommends modifications to route development standards using existing and planned navigation capabilities that will ultimately maximize the use of NAS en route airspace, enhance capacity, and accommodate the unique operational capabilities and requirements of helicopters.

This is the second in a series of three reports that address rotorcraft/helicopter standards, route structures, and procedures applies by FAA air traffic facitlites. The series consists of:

1) Rotorcraft Terminal ATC Route Standards, DOT/FAA/RD-90/18,
2) Rotorcraft En Route ATC Route Standards, DOT/FAA/RD-90/19, and
3) Rotorcraft ATC Route Standards - Implementation Guidelines, DOT/FAA/RD-90/20.

17. Key Words		18. Distribution Statement
Air Traffic Control	LORAN-C	This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.
Helicopter	Northeast Corridor	
LOFF	Tower en route control	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	48	

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PREFACE

The "Northeast Helicopter Corridor Charts," included in this report, were reproduced with permission of Jeppesen Sanderson, Inc.

Author's Note: On August 18, 1990, 14 CFR 91 was amended and paragraph numbers were changed. This document makes reference to the new paragraph numbers. The old paragraph is shown within parenthesis.

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1.0 INTRODUCTION

This is the second in a series of three reports that concentrate on existing rotorcraft/helicopter standards, route structures, and procedures applied by Federal Aviation Administration (FAA) air traffic facilities. This report focuses on the en route phase of flight and, as a result, will emphasize instrument flight rules (IFR) routes and procedures and only occasionally address the visual aspect of rotorcraft operations i.e., visual flight rules (VFR) and/or special visual flight rules (SVFR)). This report is intended to identify constraints on helicopter operations in the en route environment and to propose solutions to alleviate those constraints.

The final report in the series will provide guidelines for the development and implementation of integrated rotorcraft route structures and procedures.

Author's Note. The term rotorcraft is used as a general term that applies to all aircraft that are supported in flight partially or wholly by rotating airfoils. In this context rotorcraft include helicopters, gyroplanes, tiltrotors, tiltwings, etc. The term helicopter is used to describe a rotorcraft whose support in the air and motion through the air are derived chiefly from aerodynamic forces acting on one or more rotors turning about substantially vertical axes. Consequently, reference to rotorcraft will pertain to all four types of vertical lift aircraft while reference to helicopters does not normally include gyroplanes, tiltrotors, or tiltwings.

1.1 OBJECTIVE

The objective of this report is to recommend modifications to route development standards which will maximize the use of en route airspace, enhance capacity, and accommodate the unique operational capabilities and requirements of helicopters throughout the National Airspace System (NAS). For the purpose of this report, en route airspace is defined as all airspace within the NAS except for terminal control areas (TCA), airport radar service areas (ARSA), airport traffic areas (ATA), and other airspace normally associated with terminal approach controls.

1.2 BACKGROUND

Rotorcraft have been active in the NAS for more than 40 years. Initially, helicopter activities were exclusively associated with the military services; however, since helicopters have penetrated the civilian marketplace, commercial operations have steadily increased.

Historically, the NAS and its associated flight standards and air traffic procedures have centered on fixed-wing aircraft. This is understandable, since an overwhelming majority of air traffic is fixed-wing. As more and more airports, and an increasing amount of airspace, approach their saturation point, the relative importance of vehicles capable of vertical takeoff and landing (VTOL) will increase. Vertical lift aircraft can be operated more efficiently with updated

procedures and innovative standards that take advantage of their special capabilities.

In 1980 rotorcraft totalled less than 2 percent of the general aviation fleet and performed approximately 6.5 percent of general aviation flying hours. In 1989 these ratios had grown to 3 percent and 8 percent, respectively. The 1988 Census of U.S. Civil Aircraft indicates that the active civil rotorcraft fleet consisted of approximately 6,400 helicopters flying an estimated 2.7 million hours annually.

During the early years VFR and SVFR flight fulfilled the industry's basic needs and permitted helicopter operators to provide the services that their charters required. At that time most rotory-wing aircraft were ill-equipped to operate in instrument meteorological conditions (IMC).

In the past few years, however, missions and demand have been expanded to the extent that an all-weather capability has become more of a necessity for some helicopter operators. To meet these needs, more and more helicopters are becoming IFR-certificated and are being flown under IFR conditions. As a consequence, helicopters have begun to intrude into airspace that had previously been the private domain of fixed-wing aircraft.

At many locations, rotorcraft are perceived as newcomers to the instrument flight scene and, consequently, are considered to be interlopers that not only add to the congestion but, because of their relatively slow speeds, create additional delays. Controllers are forced to provide exaggerated separation between helicopters and faster fixed-wing aircraft for fear that the fixed-wing aircraft will overtake the helicopter and create additional operational difficulties. Therefore, slower aircraft are generally delayed in order to expedite the movement of faster traffic. Although this concept may be contrary to the intent of FAA policy, i.e., "first come, first served", it is often justified by the rationale that it is better to delay one slow aircraft rather than two or more faster ones. Such rationale is hard to dispute; even so, tacit agreement with that philosophy does not account for all helicopter delays, many of which are still attributable to air traffic procedures.

Very few helicopters communicate with air route traffic control centers (ARTCC), and IFR helicopters are so rare in the en route center's environment that the control of rotorcraft continues to be a novelty. Virtually all rotorcraft operations that receive air traffic control (ATC) services, whether they are operating VFR, SVFR, or IFR, are controlled by terminal facilities, either visually by air traffic control towers (ATCT), or on instruments (IFR) by terminal radar approach control facilities (TRACON) within tower en route system.

The major exception to this basic premise is the IFR offshore activity performed by helicopters in support of the oil industry and their

offshore oil platforms in the Gulf of Mexico. This operation is controlled by air traffic controllers assigned to the Houston ARTCC, where controllers and pilots are forced to operate in a nonradar environment due to the lack of an adequate low altitude surveillance capability. Houston ARTCC's only available long range radar sites, located in the vicinity New Orleans, LA and Houston, TX, are only usable within 30 miles of the coastline because of the helicopter's low operating altitudes.

Offshore routes are defined by domestic navigational aids (NAVAID), very high frequency onmi-directional range (VOR) radials and distance measuring equipment (DME) fixes. The minimum en route altitude (MEA) on most routes is 1,500 feet (2,500 feet within Houston's oceanic airspace).

Houston Center's personnel are not satisfied with the service they provide offshore helicopters, but they are unable to improve the service without an adequate surveillance system.

Airborne radar approaches (ARA) and offshore standard approach procedures (OSAP) have been developed for some of the platforms. If an aircraft is not destined for that particular platform, the pilot executes a point-in-space approach to VFR conditions, cancels the IFR portion of the flight plan, and proceeds VFR to the destination; FAA Advisory Circular (AC) 90-80A describes ARA and OSAP procedures.

The 1990 Rotorcraft Master Plan (RMP) envisions helicopter operations doubling over the next 20 years, with air taxi and business operations leading the early growth and a rapidly expanding intercity commuter operation following closely behind. The demand for IFR access to the NAS is expected to gradually increase in the next few years and grow dramatically in the latter part of the decade. Based on this forecast, rotorcraft could eventually provide as much as 10 percent of intercity commuter capacity within the NAS. Consequently, effective IFR access to the NAS will be necessary to enable rotorcraft to provide continuous service to the flying public, regardless of weather conditions.

Each independent company establishes its own VFR weather minimums in uncontrolled airspace, since the only limitation imposed by the Federal aviation regulations, found in title 14 of the Code of Federal Regulations (14 CFR), is the requirement to operate "at a speed that allows the pilot adequate opportunity to see any air traffic or other obstruction in time to avoid collision." The minima for most operators is a ceiling of 500 feet and visibility of 3 miles (500/3). Some operators select slightly higher or slightly lower minimums. In Alaska the accepted minimums are generally 300/1. Night VFR is not common in either locale, but when it does occur, it is typically associated with a ceiling of 1,000 feet with visibility of at least 3 miles. When weather conditions are less than these minima, operators fly IFR or cancel their missions.

2.0 INVESTIGATIVE PROCESS

The investigative process consisted of three subtasks;

(1) documentation review,

(2) data collection and analysis, and

(3) operational evaluation.

A matrix was established to ensure that a balance between each subtask was maintained during the research process. Using this matrix, existing operational standards, route structures, and air traffic control procedures were reviewed and an overview of their relationship to helicopters was developed. Site visits and personnel interviews were conducted to evaluate existing operational techniques, rule adaptations, and handbook interpretations regarding their impact on helicopter operations. Analysis of the data led to the development of recommendations to improve system effectiveness and integration of helicopters into the NAS.

2.1 REVIEW OF APPLICABLE DOCUMENTATION

In order to identify the requirements of this task, an in-depth review was made of FAA Handbook 7110.65; 14 CFR Parts 91, 127, and 135; the Airman's Information Manual (AIM); and the documents listed in the list of references.

2.2 DATA COLLECTION

After completing the review of the documents identified in paragraph 2.1, interviews were conducted with personnel representing the full spectrum of helicopter operations, both military and civilian, including air traffic control, police patrol/surveillance, pilot training, emergency medical services, executive transport, airport management, and offshore operations. More than 90 pilots, air traffic controllers, and managers representing various helicopter and air traffic disciplines, and more than 25 operators and air traffic facilities, were interviewed. Their comments and recommendations, tempered with the experience and judgement of the authors, form the basis for this report.

3.0 DISCUSSION AND ANALYSIS OF CURRENT OPERATIONS

Helicopter operators/pilots generally prefer to operate in a visual environment and at the lower operating altitudes, essentially removing them from what has traditionally been accepted as en route airspace. This permits the helicopter to utilize its unique operating capabilities most readily, that is, its ability to maneuver in confined airspace, to hover, and to fly at airspeeds varying from 0 to 175 knots.

In recent years, more and more operators have purchased helicopters that possess an all-weather capability. With this multi-million dollar investment in new equipment, they want to take advantage of the security of IFR separation. Unfortunately, the NAS is not prepared to meet these new demands and IFR helicopters continue to be considered more of a nuisance than a necessity. As IFR interaction increases between rotory- and fixed-wing aircraft, areas of conflict continue to develop, primarily in terminal airspace and to some extent within the en route environment as well.

Studies, conducted during the National Airspace Review (NAR), indicate that helicopters have not been properly integrated into the air transportation system. Traditionally, helicopters have been forced to:

(1) operate in airspace that was designed for fixed-wing aircraft,

(2) conform to standards that were established for fixed-wing aircraft, and

(3) adapt to procedures that have been designed for fixed-wing speeds and maneuverability.

While certain restrictions do exist they are mostly confined to the IFR regime; consequently, solutions may not be easily found. Rotary- and fixed-wing aircraft operating on instruments perform in a similar manner, i.e. a standard rate turn at a given airspeed will require the same amount of airspace for a helicopter as it will for an airplane flying at the same airspeed. However, the capability of a helicopter to descend at a much steeper angle than most fixed-wing aircraft is not limited to visual meteorological conditions (VMC), although the difference is not nearly as great when the helicopter descends in instrument meteorological conditions (IMC). For example, helicopters have proven, through demonstration, that flying a microwave landing system (MLS) glide path with a gradient of as much as 9 degrees is entirely feasible, while most fixed-wing aircraft are restricted to a 3 to 4 degree glide path.

IFR delays are perceived by most helicopter pilots to be the result of problems encountered prior to departure and during the approach phase of flight. There are very few traffic delays attributed directly to

en route operations. Reportedly, en route holding of helicopters is only rarely encountered in a radar environment.

In areas of the country that contain the heaviest concentrations of helicopters, interaction with ARTCC's is rare. In most of these regions, center airspace has been reconfigured and the ARTCC's have delegated airspace in the lower altitude stratum, generally 10,000 feet and below where most helicopter pilots prefer to operate, to the terminals who provide tower en route service.

3.1 TOWER EN ROUTE CONTROL (TEC)

TEC has been offered as a service to users of the aviation system for many years. The original program was designed to increase the capacity of the NAS by providing a resource in the low altitude structure that would enhance ATC services to non-turbojet aircraft involved in short range operations, i.e., flights of 2 hours duration or less. These flights receive full en route services without leaving approach control airspace.

Action was initiated in late 1981 to expand the service to provide a network of routes connecting as many adjacent approach control facilities as possible. Additional routes were identified and, in 1983, FAA Order 7110.91, "Tower En Route Control (TEC)," was published describing the program that exists today. Originally, routes were published in the Airport/Facility Directory, but once the system became fully integrated into the NAS and was accepted by the users, this was determined to be a duplication of effort and an unnecessary expense, and was subsequently discontinued. Currently, TEC routes are embedded in the ARTCC's host computer and flight plans that meet TEC requirements are automatically retained within that system.

Generally the ARTCC delegates airspace, both vertically and horizontally, to the appropriate terminal approach control. The approach control in turn provides the required air traffic services to the IFR operators within this airspace. A maximum ceiling of 10,000 feet is standard throughout the majority of TEC airspace, although in some areas altitudes are restricted to 4,000 and 3,000 feet.

Although TEC has proven to be effective, problems are still generated as traffic transitions from the en route portion of flight to the approach phase, where faster aircraft are required to be sequenced with slower moving traffic. The flight from the last en route navigational aid to the airport is controlled either by means of a standard arrival route (STAR), a preferential arrival/departure route (PDAR), or by the controller providing navigational assistance through the utilization of radar vectors.

TEC utilizes conventional VOR airways, and traffic is subject to the same flow restrictions imposed by the central flow control facility (CFCF) that are imposed on other traffic destined for the same airport.

TEC has been implemented to some extent throughout much of the country but is concentrated in high density traffic areas, such as the Great Lakes and the Atlantic, Pacific, and Gulf coasts. Since helicopters prefer to operate in the lower altitude stratum, they naturally fit into the TEC system and their pilots appear to be satisfied with the service it provides.

Ironically, some IFR-certificated helicopters operating within the TEC system are delayed to preclude confliction with slower moving fixed-wing aircraft.

Most operators expressed the opinion that there is very little need for preferential or exclusive long-range routes for helicopters. FAA Flight Standards Service personnel generally concurred with this assessment. Both groups apparently are of the belief that the existing VOR route structure is adequate for most helicopter IFR point-to-point operations. Both groups agree that there may be several exceptions to this basic premise, i.e. the Gulf of Mexico and possibly the extremely congested airspace in the Northeast and Southwest. There may be other local candidates for exclusive helicopter IFR routes, such as offshore operations in the Atlantic and Pacific and possibly in some heavily travelled intracity areas. These are rare, however, and would have to be determined on a regional, as-needed basis.

3.2 NORTHEAST CORRIDOR

Helicopters operating along the eastern seaboard between Washington D.C. and Boston, MA have been provided with a completely independent IFR system known as the Northeast Corridor. The Northeast Corridor was designed and developed for helicopters and technically is not a part of the original tower enroute program; however, since it operates within TEC airspace, the concept is similar in that approach control facilities along the route perform the en route air traffic function. In that sense, it has been evaluated here as a portion of that program.

The Corridor was developed to demonstrate the feasibility of IFR helicopter operations in high density traffic areas that would minimally impact fixed-wing traffic and the air traffic control system itself. Although the Northeast Corridor operation is encompassed within TEC airspace and controlled by approach controllers, the route structure is distinctly different and unavailable to fixed-wing aircraft.

The original need for this type of program was based on a perceived lack of compatibility between fixed-wing and helicopter airspeeds, and the presumption that helicopters do not have to go to an airport in order to transition from an IFR to a VFR environment. This assumption remains valid, although its importance has increased due to the severely constrained capacities of the major airports involved.

The Northeast Corridor was designed exclusively for helicopter operations and is based on an area navigation (RNAV) route structure located, where possible, underneath and separate from the Victor airway system. Very high frequency omnidirectional radio ranges and distance measuring equipment (VOR/DME) provide the navigational assistance. Routes are half the width of normal Victor airways.

Development of the operational plan was begun in 1974 as an FAA pilot project in conjunction with the Helicopter Association International (HAI), then known as the Helicopter Association of America (HAA). Although some segments of the Northeast Corridor were approved as early as 1975, operations officially began in June, 1979. The route selected for the corridor was from Washington, DC to Boston, MA, via Philadelphia, PA and New York, NY. (see figure 1 and 2)

The Corridor provided non-conflicting northbound and southbound airways between these cities with a variety of feeder routes, spurs, and instrument approach procedures. It was considered to be a dynamic route structure whose users would be provided with updated additions and/or changes as they were instituted.

Among the factors considered during the planning stage were:

(1) navigational coverage,

(2) surveillance and communications coverage,

(3) minimum en route altitudes,

(4) facility performance at low operating altitudes,

(5) video map accuracy,

(6) holding pattern airspace,

(7) route widths,

(8) provisions for instrument approaches, missed approaches, and departure procedures, and

(9) routes that would not interfere with existing airways.

Unfortunately, several of the factors that were considered during the planning stages were not incorporated into the implementing advisory circular. For example:

(1) there is no radar coverage on several segments of the route at the allocated altitudes,

(2) no public-use instrument approaches exist to heliports served by the Corridor, and

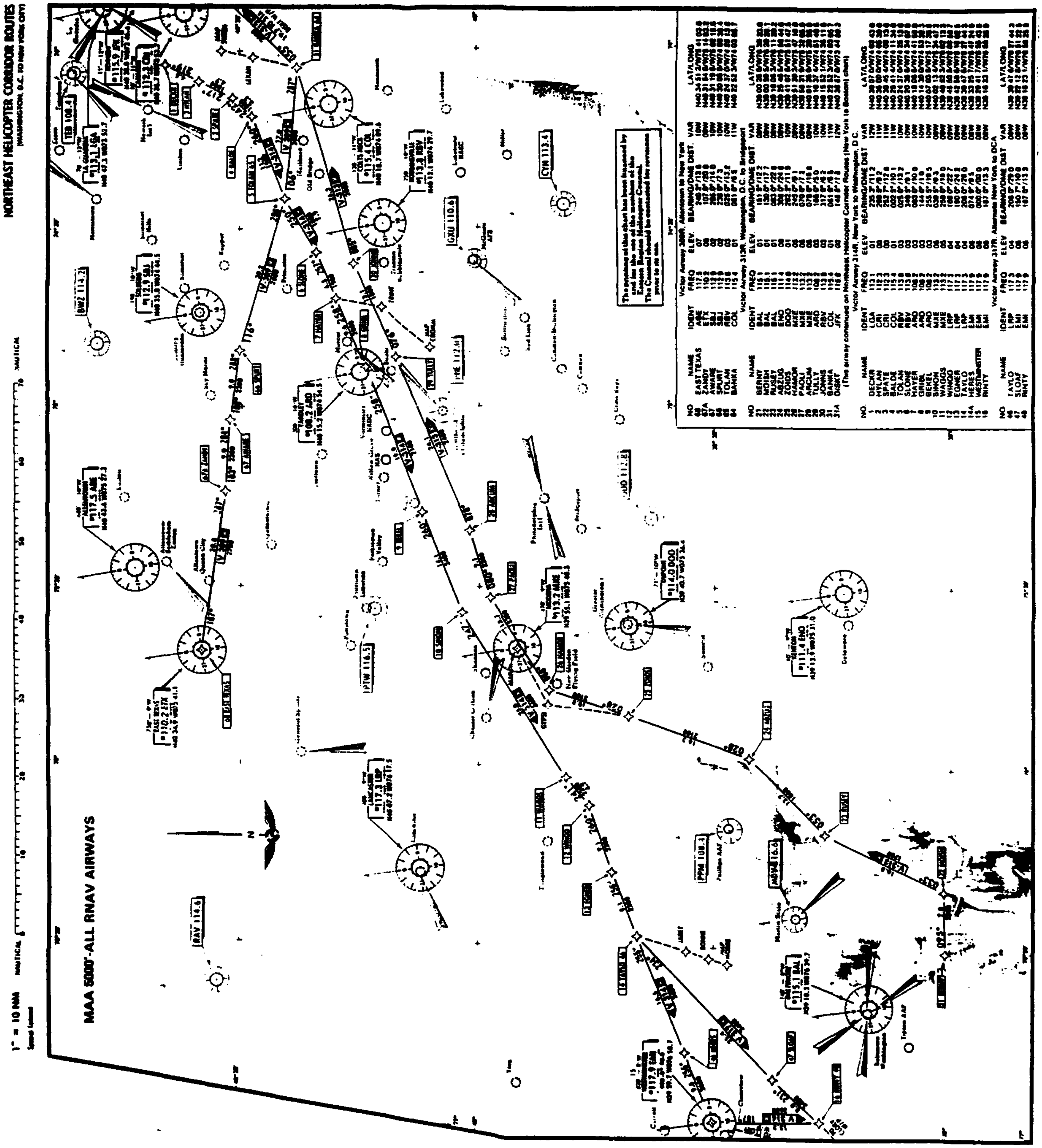

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FIGURE 1 NORTHEAST CORRIDOR
WASHINGTON, D.C. TO NEW YORK CITY, N.Y.

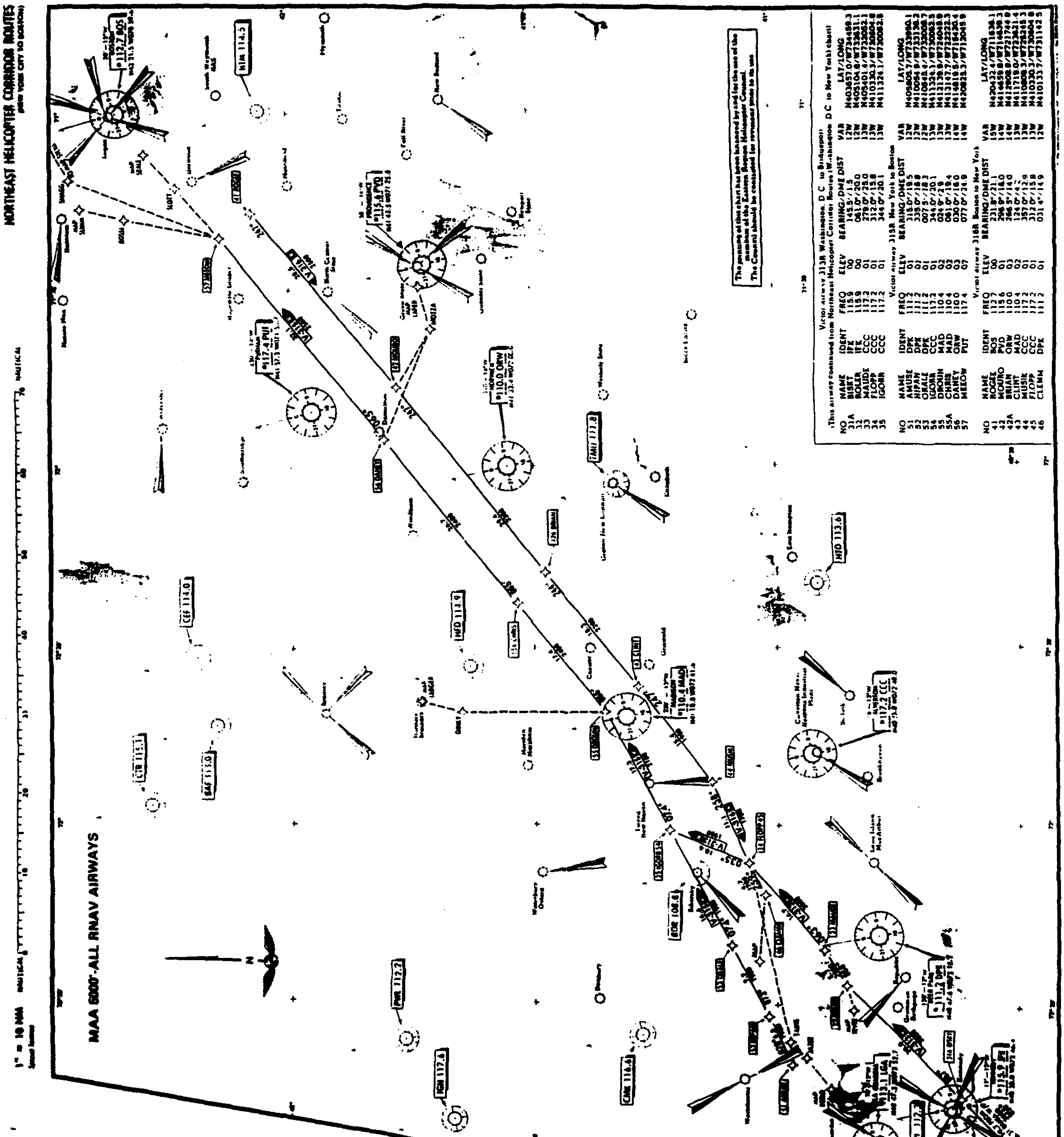

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FIGURE 2 NORTHEAST CORRIDOR
NEW YORK CITY, N.Y. TO BOSTON, MA

(3) no transition routes exists between the Corridor and conventional instrument approaches to the airports.

The routes have minimum altitudes as low as 1,700 feet above ground level (AGL) with a maximum authorized altitude of 5,000 feet mean sea level (MSL). This permits the use of approach control services throughout the entire route structure and eliminates the need for coordination with the ARTCC's.

The Corridor is predicated on the use of area navigation (RNAV), and waypoints are described with reference to VOR/DME facilities. Route widths of 4 miles (2 miles either side of the centerline) were instituted to fit the Corridor structure into existing airspace with minimal effect on previously established airways. This required the establishment of a large number of waypoints to minimize flight technical error (FTE), since RNAV route width is predicated on distance from the facility (reference AC 90-45A).

3.2.1 Analysis of Northeast Corridor Operations

Due to the intricacies of the tracks, only authorized operators are permitted to utilize the Northeast Corridor; public use is not permitted. Unfortunately, constraints placed on the operation are so cumbersome that they have rendered the Corridor and its associated approaches virtually useless.

The Northeast Corridor, despite its lack of operational use, continues to exist because of the helicopter community's refusal to allow the principles under which it was founded to be dismissed without resolution of the open issues. The procedures for obtaining authorization for use have changed slightly, but authorization can still be obtained.

IFR departure procedures have not been developed to link helicopter departure points with the Corridor. The point-in-space approaches are merely that, approaches to points, beyond which pilots are on their own to transition into some of the most congested airspace in the world.

In a 1980 briefing the FAA's Eastern Regional Office indicated that the point-in-space approach would lead to a point from which the helicopter pilot "cancels IFR and proceeds VFR to the destination." This position has not proven to be legally supportable, as the pilot cannot be required by the procedure to cancel IFR. This is the reason most procedures contain a heading and distance to the point of intended landing and also contributes to the lack of support by the air traffic community.

FAA AC 73-2, "IFR Helicopter Operations in the Northeast Corridor," provides guidelines for operation of the program. The following statements from the AC and subsequent analysis reveal several questionable areas:

1. Paragraph 2a states: "... Two one-way routes have been established which will assure safety for opposite direction traffic at the same altitudes, when the guidance in this advisory circular is followed."

The 4 nautical mile route widths were determined using terminal instrument approach procedure (TERPS) methodology that was designed for obstruction avoidance, not aircraft separation.

Route evaluations to demonstrate the ability of both the pilot and the helicopter to remain within the 4 mile wide protected airspace were flown with the RNAV systems operating in the terminal or approach modes. However, nowhere in the advisory circular are there any instructions for pilots to operate in this mode during normal operation.

2. Paragraph 2b states: "RNAV instrument approaches to a landing area or to a point-in-space are part of the Northeast Corridor concept. RNAV routes will terminate in a helicopter RNAV or conventional instrument approach procedure. Conventional instrument approaches may also be used at a destination airport. ..."

No interface has been designed between the Corridor and conventional approaches to airports or heliports. Consequently, no convenient transition is available between the Corridor and published conventional instrument approaches.

3. Paragraph 2d states: "... A pilot operating IFR on this structure with improper equipment or inadequate pilotage technique could disrupt air traffic operations along the conventional airway system ... In addition to the route width reduction, the RNAV holding pattern airspace on this route is smaller than holding pattern airspace for conventional aircraft."

In today's environment, helicopters regularly hold at airspeeds equivalent to some fixed-wing aircraft, with IFR maneuvering airspace requirements being identical. Reduced holding pattern airspace may not be attainable.

Nowhere in the advisory circular are the needed pilotage techniques defined, the specialized training requirements specified, or the holding pattern parameters described that are necessary to remain within the reduced airspace.

Radar surveillance of portions of the routes is not available. This can result in excursions from the protected airspace going undetected.

4. Paragraph 3a states: "Sections 91-116, 91-119, and 91-123, Part 91, of the Federal Aviation Regulations contain requirements concerning takeoff and landing, minimum altitudes, and course to be flown that must be complied with under IFR "unless otherwise

authorized by the Administrator." In the interest of the safe and efficient expansion of helicopter operations, the Administrator hereby authorizes deviation from the cited regulations to the extent needed to permit helicopter operation on the Northeast Corridor routes..."

While waiving certain requirements of 14 CFR 91-175 (91-116) is certainly plausible when dealing with rotary-wing operations, it should be accomplished with the view of establishing some alternative to insure the continuity of safety for which the basic rule was written. For example, the approach to White Plains, NY, Copter RNAV-286°, has a minimum descent altitude (MDA) of 300 feet over Long Island Sound. This raises two questions: (1) What is the tallest ship that can be in the vicinity of the missed approach point? The nonprecision MDA should be predicated upon a 250 foot obstruction clearance above that height. (2) At an altitude of 300 feet, with 3/4 of a mile visibility, 5 miles from shore, what is the pilot going to see that verifies he/she is in the right place and can continue the 15.1 miles to land at Westchester County Airport? The only justification for this type of waiver appears to be expediency, while safety of flight should always be the prime factor in any waiver approval.

5. Paragraph 3b states: "To insure that only authorized operators will utilize this corridor, public use en route or approach charts will not be issued until the route has been designated for public use. ..."

After 11 years of availability, public use has still not been attained and to describe its use as occasional would be an exaggeration.

6. Paragraph 3e states: "In establishing the initial structure, it was deemed necessary to establish a considerable number of waypoints due to the complexity of the corridor and minimize flight technical error. Frequent bearing changes are necessary ... It is expected that the corridor can be redesigned in some areas, thereby reducing the number of waypoints. During this initial period, however, it is considered undesirable to make changes in the prescribed route due to necessary follow-on requirements such as changing approach control video maps, special notification to users, and resultant changes to their operating charts; and the need for special flight checks to assess obstacle clearance, signal coverage and establishment of precise coordinates."

Since these words were written, virtually nothing has happened. The Corridor has not been straightened; many controllers are not aware that the Northeast Corridor exists, let alone that they have a video map depicting it; and little if any notice is disseminated about activities that effect the Corridor.

Today's technology, in the form of greatly improved RNAV computers, multiple sensor receivers, long range navigation (LORAN-C), DME/DME

systems, etc., effectively removes many of the previous reasons for inaction, yet inaction continues.

The lack of an operational need on the part of the helicopter community for the Corridor in its present configuration appears to be the primary reason why there has been no user push for follow-on work.

7. Paragraph 3g states: "... Point-in-space approaches are not limited by distance from the point-in-space to the point of intended landing; however, they will normally be in close proximity to a landing area. Point-in-space approach procedures will identify the available landing area or areas in the vicinity by course and distance from the missed approach point."

A review of the approach procedures indicates that neither of these requirements were followed very closely.

Philadelphia, PA - Copter RNAV-070° (figure 3)
missed approach point (MAP) to point of intended landing - 19.9 miles.

White Plains, NY - Copter RNAV-286°
MAP to point of intended landing - 15.1 miles.

Baltimore, MD - Copter RNAV-205°
MAP to point of intended landing - 18.6 miles.

Washington, DC - Copter RNAV-184°
MAP to point of intended landing - 15.1 miles.

New York, NY - Copter RNAV-271°
MAP to point of intended landing - 17.4 miles.

All of the above approaches indicate course and distance to the point of intended landing; however, the indicated courses cannot be flown consistently because of numerous airspace conflictions.

Other approaches indicate no point of intended landing or course and no distance information at all.

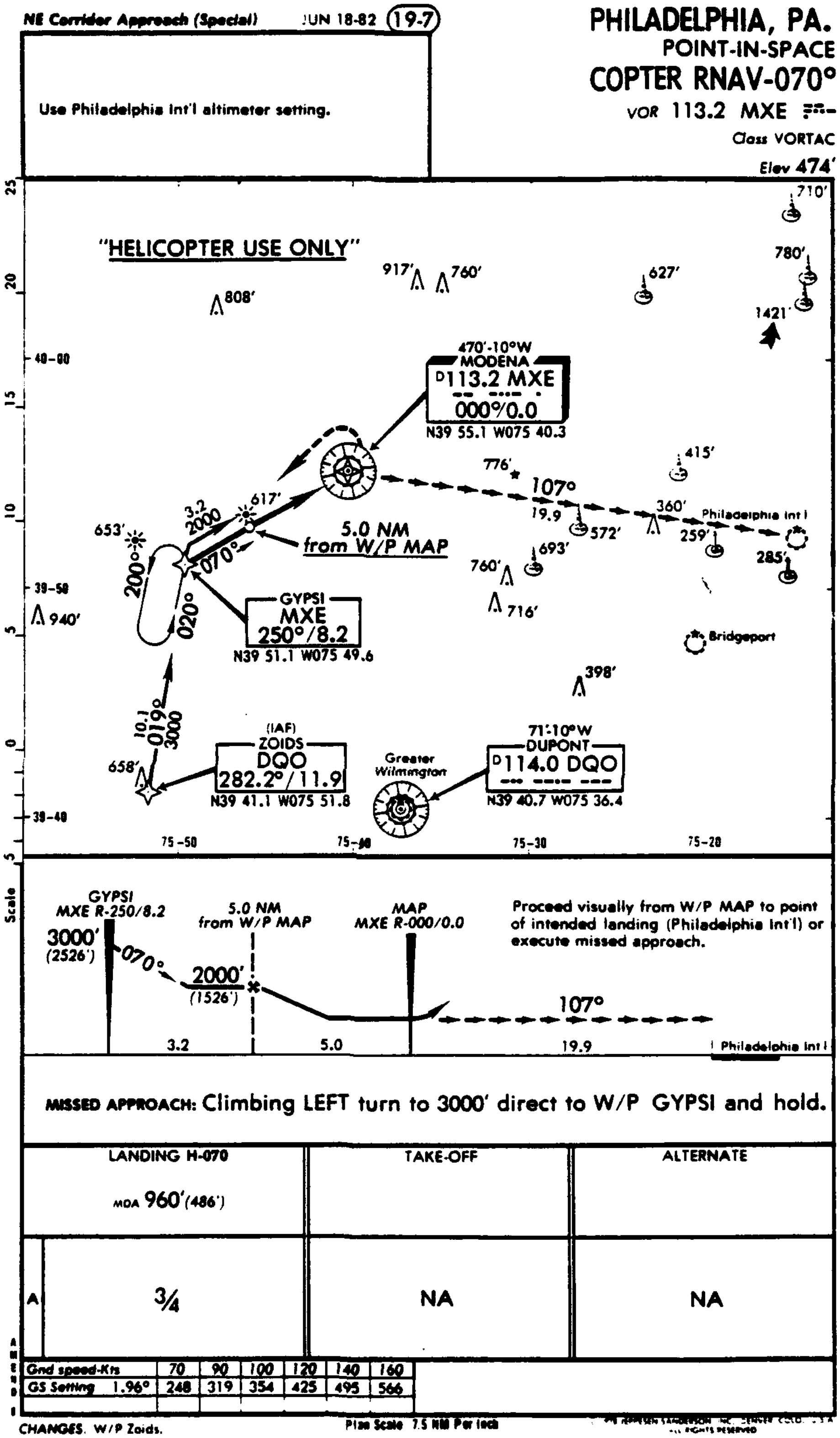
New York, NY - Copter RNAV-241° (figure 4)

New York, NY - Copter RNAV-026°

Philadelphia, PA - Copter RNAV-229°

Further review of point-in-space approach procedures raises the question of compliance with 14 CFR 135.183, which states:

"Performance requirements: Land aircraft operated over water.



Gnd speed-Kts	70	90	100	120	140	160
GS Setting 1.96°	248	319	354	425	495	566

FIGURE 3 PHILADELPHIA, PA POINT-IN-SPACE APPROACH
Copter RNAV-070°

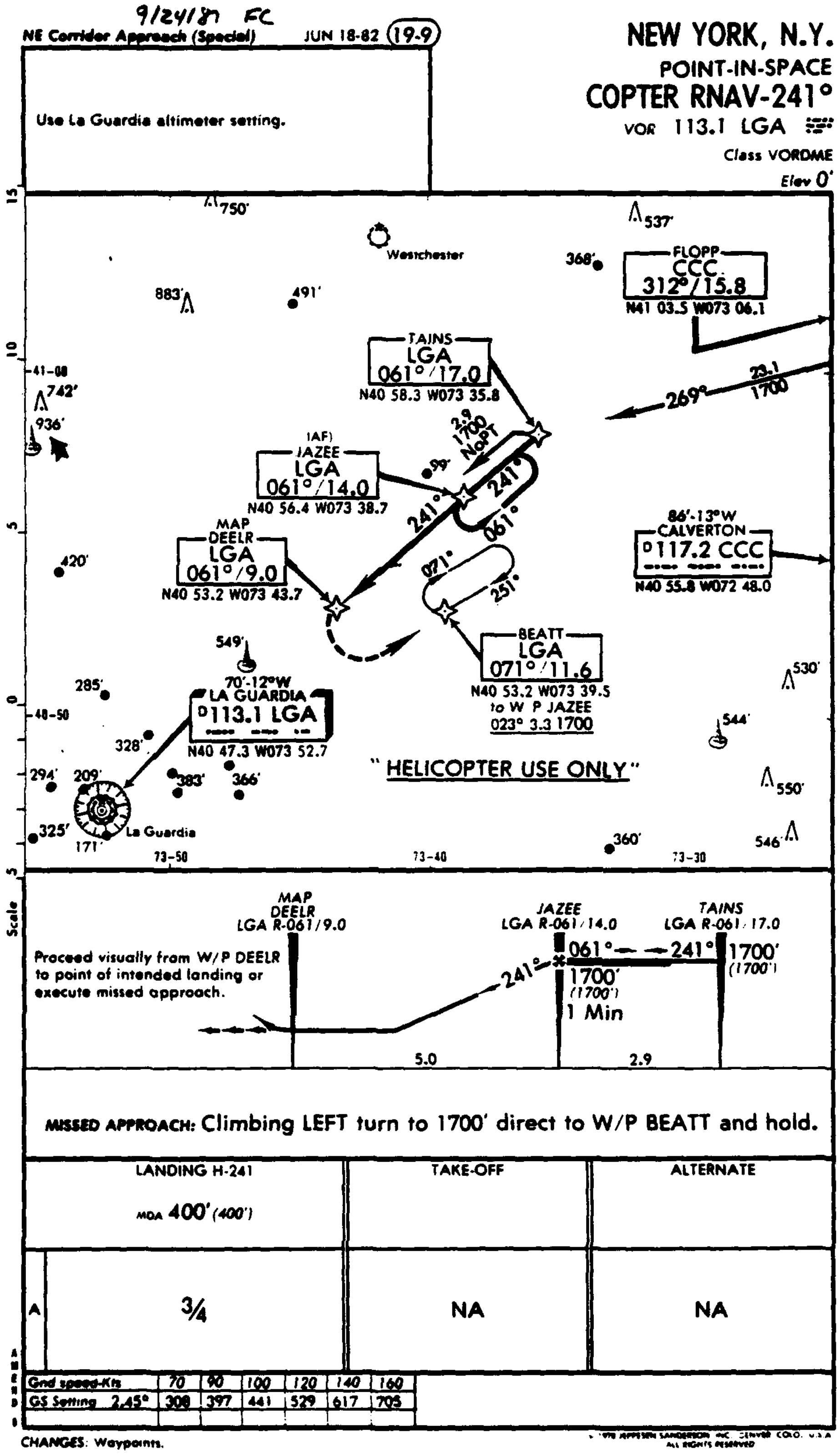


FIGURE 4 NEW YORK, N.Y. POINT-IN-SPACE APPROACH
Copter RNAV-241°

No person may operate a land aircraft carrying passengers over water unless -

(a) It is operated at an altitude that allows it to reach land in the case of engine failure;

(b) It is necessary for takeoff or landing;

(c) It is a multi-engine aircraft operated at a weight that will allow it to climb, with the critical engine inoperative, at least 50 feet a minute, at an altitude of 1,000 feet above the surface; or

(d) It is a helicopter equipped with helicopter flotation devices."

Helicopters using the approaches could (1) be restricted from carrying passengers, (2) be required to be multi-engine with single-engine climb capability, and/or (3) be required to carry flotation devices.

It is questionable whether the statement in (b) "It is necessary for takeoff or landing" can be stretched to cover approaches that take place nearly entirely over water with no landing site indicated.

Additionally, why are approaches which terminate over water, often several miles from land, not restricted to greatly increased visibility requirements or denied night time operations to comply with the visual and/or surface light reference requirements of 14 CFR 135.207, which states:

"No person may operate a helicopter under VFR unless that person has visual surface reference or, at night, visual surface light reference, sufficient to safely control the helicopter."

Corridor charts are controlled and distributed by the Eastern Region Helicopter Council (ERHC). The ERHC contracted with Jeppesen Sanderson Inc. of Denver, Colorado for printing services.

The following discrepancies have been noted in the control and distribution process:

1. The ERHC issues three sets of approach procedures and three sets of Northeast Corridor charts. Undated pen and ink changes are sent along with the package for changes that have taken place years earlier.

2. Chart subscribers normally receive updates as changes occur. The package procured for this study was ordered in December 1987 and received in the same month. On November 3, 1987, the Boston

VORTAC was relocated on Logan Airport and no notification of the change was included in the package. The VORTAC was returned to service in its new location and recommissioned on January 21, 1988. The FAA made necessary changes to the approaches effected by the move and flight inspected them. To this date, no changes have been forthcoming for chart holders denoting changes to the Corridor or to procedures.

3. When the Corridor was originally constructed, users of point-in-space approaches were to be charged a reimbursement fee for flight inspection services, since the approaches were all "specials." Reimbursement fees have not been collected for some time even though the FAA has continued to flight inspect the approaches. The Eastern Region intends to look for reimbursement in the near future if for no other reason than to ascertain if anyone still uses the procedures and to justify their continued inspection.

4. The Northeast Corridor has not been carried as either a Part 95 or a non-Part 95 airway since its inception. This means that it is not considered during analysis of construction proposals or in any other matter which affects the use of navigable airspace, unless it happens to be remembered by the airspace specialist performing the particular obstruction evaluation. A primary oversight occurred during the development of the East Coast Plan, when planners allowed no consideration of the Corridor in reconstructing the new operating system. For example, the northern leg of V-316R between waypoints MOURO and ROGEE (figure 5) crosses from 3 miles west to 3 miles east of V3-16, passing directly over WOONS (the initial approach fix for the VOR/DME RWY 16 approach to Providence, RI). Additionally, V-315R virtually parallels V475, a heavily travelled airway, closing to less than 3 miles between HIPAN and DROUN, while crossing five other Victor airways (V483, V433, V91-487, V229 and V34) in the process. This restricts air traffic control's operation of the Corridor without radar.

3.2.2 Uncontrolled Airspace

Point-in-space approaches developed for use in conjunction with the Northeast Corridor were designed without the establishment of a control zone encompassing the arrival airspace. This means that the helicopter is descending from instrument conditions into uncontrolled airspace, and possibly into unknown and uncontrolled traffic, in an area where radar surveillance may not be provided. While it can be said that the same thing occurs at uncontrolled airports, two major differences exist. First, pilots operating at uncontrolled airports are aware that there is the possibility of IFR arrivals, their approximate direction of flight and altitude, and where in the traffic pattern they can expect to encounter them. Thus, they are on the lookout for them. Secondly, UNICOM and/or the common traffic advisory frequency (CTAF) are available for pilots to announce their

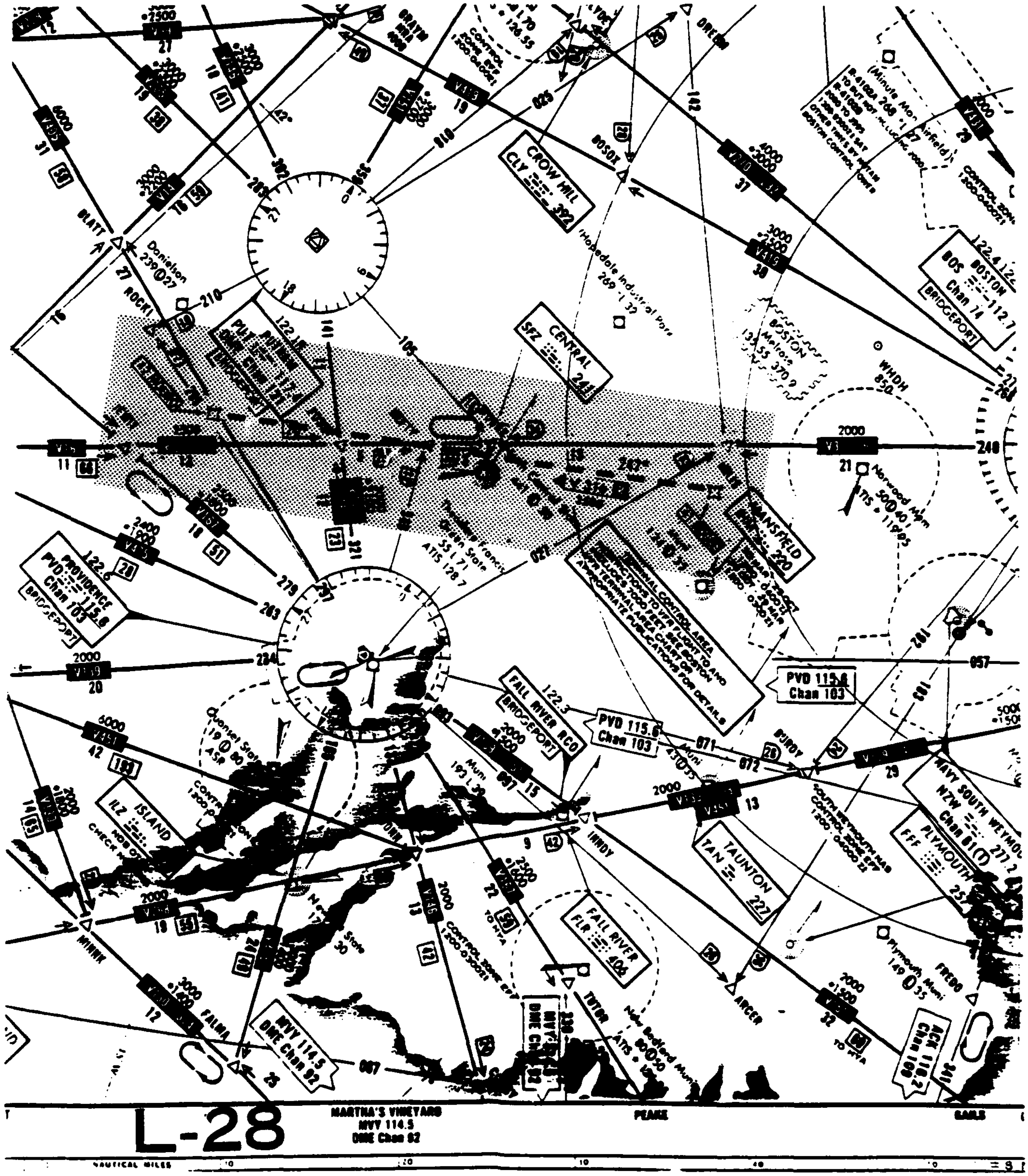


FIGURE 5 V-316R MOURO - ROGEE
(OVERLAID ON EN ROUTE LOW ALTITUDE CHART L-28)

arrival/departure intentions. The Northeast Corridor point-in-space approaches allow descent into same direction, crossing and/or opposing traffic without warning. This is at least undesirable, and totally unsafe.

3.2.3 Air Traffic Controller Awareness

Air traffic controllers appear to lack an awareness of the existence of the Northeast Corridor, and are unaccustomed to its use. They are even less familiar with the point-in-space procedures associated with it. To be successful, any en route or approach procedure must be understood by both those who use it and those who control it.

There is an additional problem of far greater importance to the entire helicopter industry, the lack of operational capability awareness on the part of the controller. While individual operators/organizations have gone to considerable effort to educate local controller personnel, a standard, up-to-date capability and limitations presentation is not readily available to controllers. Therefore, controllers are often uncertain of exactly what the helicopter pilot is requesting, what he or she is capable of accepting, or what exactly he or she will do after receiving a particular instruction. Since the helicopter has a unique operating capability in visual conditions, controllers often expect that same capability in instrument conditions. They are also often unaware of the limitations caused by wind, temperature, high gross weight, turbulence, icing, etc., all of which can profoundly affect operations.

3.2.4 Terminal Instrument Procedures

In April 1983, Handbook 8260-3, "United States Standards for Terminal Instrument Procedures (TERPS)" was amended to incorporate chapter 17, En Route Procedures. The Northeast Corridor is not in compliance with the criteria in this directive. A waiver should be required, but none has been processed.

3.2.5 Inappropriate Altitude Assignments

Radar coverage does not permit surveillance of the entire route. This results in ATC assigning 6,000 and 7,000 feet as the en route altitude although AC 73-2 establishes the maximum altitude in the Corridor as 5,000 feet.

3.2.6 Altimeter Source and Lighting Requirements

Point-in-space approaches that are not to airfields or heliports with a weather reporting capability deny the pilot current weather information and, more importantly, a current altimeter source to execute the published instrument approach. The use of remote altimeter sources is under close scrutiny by the Office of Flight Standards, and may in the future no longer be authorized. Additionally, verification of arrival at the proper "point-in-space"

comes under serious question when considering adoption of any public point-in-space procedure, especially during night operations. There should be a requirement to provide some type of lighted or identifiable ground marker to assure the pilot that he or she has arrived at the proper point from which to proceed visually to the destination. Both of these issues must be resolved before point-in-space procedures can become a reality for public use.

3.2.7 Approach Minimums for Public-Use, Point-in-Space Procedures

Several of the procedures published for use in the Northeast Corridor have minimums of 30C to 400 feet and a visibility requirement of only 3/4 of a mile. It is unreasonable to expect a pilot, unfamiliar with the local area, to arrive under those conditions and then proceed 15 miles in reduced visibility through unfamiliar terrain to an unfamiliar heliport for landing (see figure 4).

3.2.8 Additional Points of Concern

1. It is a fairly common belief among controllers in the New England Region that "the Northeast Corridor lost its value when the point-in-space approaches were cancelled." On the contrary, the approaches have not been cancelled. They still exist, although very few controllers are aware of them nor do they know how to introduce them into the system.

2. In 1987 the FAA published a helicopter route chart for the New York area. During development of this chart, no consideration was given to the existence of the Northeast Corridor, and consequently, there is no linkage between the routes. In early 1988 a chart for the Washington, DC area was also published but again, no consideration was given to linking the Corridor with the published routes. The same comment can be made for the Boston helicopter chart published in 1989.

3. In 1981 the Corridor was temporarily suspended for modification and seven waypoint changes were initiated which were said to be necessary to satisfy the requirements of the 4 mile route width. These changes were not implemented by standard methods but by means of a letter from the FAA Flight Standards Service distributed to the users.

A route structure designed around a system similar to the Northeast Corridor could be the precursor to an eventual IFR helicopter airway structure linking major metropolitan areas. This could segregate the flow of helicopters and fixed-wing aircraft. Unfortunately, the existing Corridor does not meet this standard and needs considerable modification before it could.

3.3 EN ROUTE SERVICE IN THE GULF OF MEXICO

There are more than 600 helicopters operating between the United States mainland and offshore oil platforms in the Gulf of Mexico. This fleet supports an estimated 4,000 oil rigs of which approximately 1,500 contain helipads. Most existing platforms are located within domestic airspace, presently established at 100 nautical miles, while some are located as far as 160 miles from landfall. It is believed that by the turn of the century, drilling platforms will be constructed as far as 200 miles out to sea.

The majority of these helicopters are scheduled to make three round trips into the Gulf each day, sometimes more. When the weather deteriorates, a number of these missions are either cancelled or delayed due to the lack of an appropriate IFR surveillance system. Since shore-based long range radars are not capable of tracking low flying helicopters more than 30 miles from shore, air traffic control must resort to nonradar separation standards which require 20 miles or 10 minutes spacing between aircraft to provide a guaranteed margin of safety.

3.3.1 Operational Requirements

Although total helicopter operations in the Gulf are a long way from reaching the peak numbers that were experienced in the 1970s, Gulf traffic is increasing, and more and more emphasis is being placed on IFR operations. Both FAA personnel and helicopter operators anticipate that previous peaks will be exceeded by the year 2000.

Approximately 125 IFR-certificated helicopters operate in the Gulf area today. Many of the owners expressed their desire to operate IFR 100 percent of the time, regardless of meteorological conditions. However, due to existing constraints (nonradar separation standards, alternate airport requirements, enforced delays, limited route structures, etc.), they could lose as many as 30 percent of their sorties when operating in this mode. Losses of this magnitude would be devastating to helicopter owners, since they operate on minimal profit margins. Consequently, the majority of operations are conducted visually.

One oil company recently made a public announcement that it intended to begin some exploratory drilling for oil 200 miles out in the Gulf beginning in the 1991-92 time frame. This announcement corroborates the perception that drilling platforms well beyond existing boundaries will require rotorcraft support before the year 2000. All-weather capability will be a necessity if such a requirement becomes an actuality, and existing air traffic nonradar separation standards will be unacceptable.

3.3.2 Future Offshore Service Needs

A request was recently received by FAA Headquarters to extend domestic airspace into the Gulf of Mexico to 200 nautical miles, approximately doubling the existing limits. Approval of this request would generate additional problems for the air traffic control system in that area. It would require that offshore aircraft separation standards equate to the standards that exist throughout the NAS and not the existing International Civil Aviation Organization (ICAO) standards currently utilized in oceanic airspace. (Oceanic airways are 100 nautical miles (nm) wide, whereas standard domestic VOR airways are only 8 nm wide.) To provide domestic route accuracy, dependable communications, navigation, and surveillance (CNS) systems would be required, and in the remote chance that the primary navigational system fails or becomes unreliable, backup systems would also have to be in place.

3.3.3 Offshore Surveillance

One solution to the surveillance problem, albeit an expensive one, would be the installation of several strategically placed air route surveillance radar (ARSR) systems on platforms in the Gulf of Mexico. In addition, remote communications air/ground facilities (RCAG) would be required to permit controllers and pilots to communicate, and microwave relay facilities would be required to provide radar data to the controlling facility.

Houston ARTCC submitted a request for funding in 1988 for the installation of three offshore long-range radar sites, eight low altitude navigational aids, and eight remote communications facilities with very high frequency (VHF) and ultra high frequency (UHF) capabilities in the Gulf of Mexico. This would provide surveillance for helicopters in support of the oil platforms in today's area of operation. However, if recently announced exploratory drilling operations are successful, at least four separate radar installations might be necessary. Initial estimates are approximately $15 million dollars per installation for the radar alone. Added to the cost of the necessary support equipment such as RCAG's and NAVAID's the total expenditure could exceed $70 million dollars. This high cost is causing a number of FAA engineers to look at alternative surveillance techniques (see Section 4.3).

An economical alternative to radar would be the use of LORAN-C offshore flight following (LOFF) for surveillance. The system has been tested in Houston ARTCC utilizing helicopters that operate in the Gulf of Mexico and, although tests indicate that displayed aircraft positions differ slightly from radar correlated positions, the differences are quite small and affect all participating aircraft in a similar manner. LOFF has the potential to provide tracking and separation services in areas where radar is not available.

The system utilizes the LORAN-C derived aircraft position, transmitted via data link to the ARTCC, where a convertor transforms the position

data into radar message format and displays it on the controller's radar scope like conventional radar targets. If the system becomes operational, it appears to be capable of providing surveillance coverage throughout appropriate areas of the Gulf.

Simulation and testing of the LOFF program indicate that although its repeatable accuracy may not meet the accuracy requirements of radar, the system performs consistently and targets located in close proximity to each other are displayed in the appropriate positions relative to each other. Even if LOFF does not provide radar accuracy, tests indicate that it is accurate enough to permit its use by air traffic control in providing some aircraft separation services.

In most en route environments utilizing broadband radar or the en route automated radar tracking system (EARTS), radar separation is considered to be 5 miles. Nonradar separation is defined as 20 miles between aircraft using DME and/or RNAV, or 10 minutes between other aircraft. While LOFF may never meet the 5 mile standard possible with radar, it appears to have the potential to safely permit the use of 10 mile separation under most circumstances. Ten mile separation could roughly double the IFR capacity of today's Gulf operations.

Several of the individuals that were interviewed expressed doubt that LOFF would ever be used for separation purposes unless all aircraft utilizing the airspace were equipped with LORAN-C. This rationale seems rather simplistic. Operators prudent enough to equip their aircraft with appropriate navigational equipment should enjoy the benefits of their investments. For those more frugal operators, it would be possible to establish different, and likely more circuitous, non-surveillance routing.

3.3.4 Offshore Navigation

The existing LORAN-C chain(s) provide the necessary capability both to support airborne navigation and LOFF, although it would require a backup in the event of a system failure. Airborne automatic direction finder equipment (ADF) and airborne weather radar could provide this backup system in the event of an emergency. Shore-based facilities could provide adequate homing signals for the ADF and many oil rigs are equipped with privately-owned non-directional beacons (NDB) that could provide assistance.

FAA Order 8260.3B, chapter 17 describes a low frequency airway, defined by a series of NAVAID's spaced about 50 miles apart, that would provide a 10 mile wide airway. Since there are numerous oil platforms throughout the Gulf, it would seem reasonable that a network of NDB's could be installed on selected rigs to develop a low-frequency (colored) airway system within the Gulf for backup in the event of a primary system failure. Resurrection of this airway concept could provide standby navigational backup at reasonable cost, although there could be problems developing this concept if the data

in a 1982 report indicating NDB frequency congestion in the Gulf area is still valid (see reference 1).

3.4 SUMMARY

The analysis looked at three different types of IFR ATC helicopter en route systems: tower en route control, the Northeast Corridor Program, and the Gulf of Mexico offshore operation.

3.4.1 Tower En Route Control

TEC has been implemented in many parts of the United States and is generally successful at integrating low altitude traffic into the overall ATC system. Shortfalls regarding IFR helicopter operations within the TEC include:

1. a lack of specific routes connecting heliports and vertiports to the TEC network,

2. the lack of instrument approach procedures to heliports and vertiports and,

3. the lack of helicopter unique approaches into congested airports.

The main problem in expanding the TEC to incorporate IFR helicopter operations is whether it is possible to develop unique helicopter transition routes and approaches to congested airports.

3.4.2 Northeast Corridor

The Northeast Corridor was developed to demonstrate the feasibility of IFR helicopter operations in high density traffic areas that would have minimal impact on fixed-wing traffic and the ATC system. In addition to the shortfalls associated with the TEC system, the Corridor incorporates several other deficiencies, such as:

1. the lack of radar coverage on several segments of the route at maximum Corridor altitudes,

2. the excessive number of waypoints needed to control route widths, leading to excessive pilot workload,

3. the point-in-space approaches, developed in conjunction with the Corridor, terminate in uncontrolled airspace and in areas where radar surveillance may not be provided, and,

4. the lack of compliance with TERP's standards.

3.4.3 Gulf of Mexico Offshore Operations

The VFR system in the Gulf works very well, however, the IFR system is constrained by the ATC requirement to use nonradar separation standards. The Gulf operation needs a surveillance system to improve the IFR operation. Installation of radar is one solution, albeit an expensive one. LOFF, or perhaps automatic dependent surveillance (ADS), appears to offer a lower cost alternative if technical and integrity problems can be overcome.

4.0 ANALYSIS OF ATC SUPPORT FUNCTIONS

4.1 COMMUNICATIONS

Communications frequency congestion in virtually any major metropolitan area creates constant concern for the safety of an operation. The inability to communicate results in excessive time delays, undue frustration, inefficient and/or inadequate transfer of required information, and unnecessary risk on the part of many operators. An acute awareness of the problem and pilot/controller diligence have thus far averted any accidents. With the ever-increasing number of operators, the situation only worsens. In some areas the problem revolves not only around congestion but, to an even greater degree, controller workload.

At many busy locations, especially during heavy fixed-wing traffic periods, helicopters are controlled from an operating position that is dedicated exclusively to the control of helicopters and on a discrete frequency. When a discrete frequency is utilized it normally encompasses airspace that underlies or is included in some other airspace block and serves two purposes: first, it enables air traffic to control the helicopters, and secondly, it enables the helicopter pilot to monitor reports from other helicopters operating along the same routes. This extra benefit provides additional traffic information to the pilot and further enhances the safety of the VFR system. However, it is normally not germane to en route and/or instrument operations, where all aircraft within a given sector communicate with the controlling agency on the same frequency.

Operators are not aware of any other significant communications problems in their primary operating areas; however, they reported some communications difficulties in tower en route airspace, especially at minimum enroute altitudes (MEA). Although they rarely had difficulty hearing tower transmissions, it was not uncommon for the tower to have problems hearing helicopters, especially in the outer fringes of their airspace. Whether this was a problem with aircraft transmitters or the result of the low altitudes used by helicopters could not be determined. It does, however, indicate that there is a need for additional remote communications facilities (RCF). These RCF's should be located in the vicinity of normal communications transfer points throughout the TEC system.

4.2 NAVIGATION

4.2.1 Long Range Navigation (LORAN-C)

Navigational capabilities have been greatly enhanced for helicopters with the introduction of LORAN-C, providing pilots with both IFR and VFR capabilities. Because they operate for the most part VFR, pilots using LORAN-C RNAV have greatly increased navigational efficiency by improving their ability to map-read while maintaining proper visual vigilance.

Very few LORAN-C receivers are certified for an approach function. Operators will incur a recertification cost to upgrade their airborne avionics.

As LORAN-C instrument approach capabilities become available, heliports will be able to have instrument approaches without the added cost of equipment and the need to provide space for a ground-based navigational aid. Currently, the only LORAN-C, off-airport, public-use approach in use has been implemented at Venice, LA.

4.2.2 Global Positioning System (GPS)

GPS must be viewed as a long-range solution for helicopter navigation. The basis for this conclusion include: (1) the current development status of the system, (2) the unresolved system integrity issues, (3) the unknown reliability capabilities and, (4) the yet to be determined access to the full capabilities of GPS by civil users.

Although GPS offers promising navigational possibilities, the system is in its infancy and will require an extended test and evaluation period prior to certification and approval for use as part of the NAS. It may eventually provide additional en route navigation opportunities for rotorcraft. It may also provide the pilot with a nonprecision approach capability to virtually any location in the world. Proponents believe that enhanced GPS, either in the form of differential GPS or access to all the capabilities of the military system, may also provide a Category I precision landing capability to nearly any point in the world. From a technical viewpoint, these capabilities appear to be achievable. It remains to be seen whether the political and operational realities allow the full technical capabilities of GPS to be available to civil aviation.

4.2.3 Microwave Landing System (MLS)

MLS was designed as an approach and landing aid but, with its broad area coverage ($\pm$40 degrees and $\pm$60 degrees), combined with an RNAV capability, if offers the potential for a highly accurate navigation system within the tower enroute environment.

4.2.4 Very High Frequency Omni-directional Radio Range/Distance Measuring Equipment (VOR/DME)

Normally VOR/DME coverage is adequate in most terminal areas, however, coverage may be somewhat limited in outlying en route areas. Remote locations which do not have terminal activity face the possibility of not having VOR/DME coverage. The operational parameters of VOR/DME do not offer reception beyond line-of-sight. Since the normal operating strata of helicopters is normally considered to be remote and low altitude it is doubtful that adequate navigational support can be effectively derived from this system because of terrain and obstructions.

4.2.5 Nondirectional Radio Beacon (NDB)

NDB's transmit a low or medium frequency signal whereby pilot can determine their bearing from the station and "home" on the station. This is a low cost venture that provides a certified navigational means for both approach and en route navigation. These facilities actively support primary and backup airway route systems throughout the continental U.S. and Alaska.

Erratic response to atmospheric disturbances occasionally result in erroneous navigational information and a less than desirable condition for en route navigation over extended distances. They are used widely as a means to locate and identify the marker beacon for precision approaches, and require significant pilot workload.

4.3 SURVEILLANCE

There is a definite shortage of surveillance coverage in the en route environment at the operating altitudes preferred by helicopters, as evidenced by operations in the Gulf of Mexico. Generally, surveillance coverage in terminal airspace is adequate, and it is available to provide service to surrounding heliports in addition to the major airport.

While surveillance is not essential to air traffic control in low density traffic areas, the delays associated with the lack of it can make IFR operations impractical for both operator and controller. Essentially, the most meaningful and productive air traffic services are provided only where radar coverage is available. In this regard, the helicopter community is a long way from receiving essential air traffic services and consequently has been thwarted in its attempt to break into the IFR environment.

4.3.1 Radar

Radar is the backbone of the current ATC system and is available in virtually all congested terminal areas and along current IFR routes. However, since radar is limited to line of sight there is a lack of coverage in many areas where helicopters fly because of their low operating altitudes. In addition, radar surveillance is an expensive alternative since both primary and secondary radar systems are costly.

4.3.2 Automatic Dependent Surveillance (ADS)

The FAA's 1990 Capital Investment Plan (CIP), addresses new projects, one of which is ADS. ADS is a research and development (R&D) project intended to enhance aviation safety and efficiency in airspace that is currently beyond radar coverage. Oceanic airspace is expected to receive initial implementation of the ADS. It will allow air traffic controllers to monitor flight paths to ensure that route deviations are recognized and corrected prior to aircraft confliction. An aircraft's position data will be relayed to the ARTCC, through a

satellite data link network, where it will ultimately be displayed on the controller's radar scope and possibly result in reductions in separation minima, and increased accommodation of user-preferred routes and trajectories. There are however questions as to the suitability of ADS for small aircraft, weight penalties for the necessary antenna, aircraft avionics, and associated cabling can exceed 155 pounds, the loss of a passenger seat. This cost penalty probably means that helicopters are unlikely to become involved in a true ADS operation (reference 5).

Conceptually ADS is the same as LOFF; however, the communications data link for LOFF is ground-based rather than satellite-based as it is for ADS.

4.3.3 LORAN-C Offshore Flight Following (LOFF)

LOFF is a variation of an ADS system, described in the CIP as an automatic independent surveillance system. LOFF utilizes LORAN-C derived aircraft position in latitude and longitude, sends the information to a transceiver and transmits it via data burst on VHF to the ATC computer. The data is converted into a standard common digitizer format, providing pseudo beacon reply messages to the computer and finally displaying track and data on the controller's display. It was tested in Houston ARTCC utilizing helicopters that operate in the Gulf of Mexico. If the system becomes operational, it appears to be capable of providing surveillance coverage throughout appropriate areas of the Gulf.

Although tests indicate that displayed aircraft positions differ slightly from radar correlated positions, the differences are quite small and affect all participating aircraft in a similar manner. LOFF has the potential to provide tracking and separation services in areas where radar is not available.

Simulation and testing of the LOFF program indicate that although its repeatable accuracy may not meet radar accuracy requirements, the system performs consistently and targets located in close proximity to each other are displayed in the appropriate positions relative to each other. Even if LOFF does not provide the accuracy of radar, tests indicate that it is accurate enough to permit its use by air traffic control in providing aircraft separation services.

In most en route environments utilizing either broadband radar or the en route automated radar tracking system (EARTS), radar separation is considered to be 5 miles. Nonradar in-trail separation is specified as 20 miles between aircraft using DME and/or RNAV, or 10 minutes between other aircraft.

While LOFF may never meet the 5 miles standard possible with radar, it appears to have the potential to safely permit the use of 10 miles separation under most circumstances. Ten miles separation could roughly double the IFR capacity of today's Gulf operations.

Several of the individuals that were interviewed expressed doubt that LOFF would ever be used for separation purposes unless all aircraft utilizing the airspace were equipped with LORAN-C. This rationale is rather simplistic. Operators prudent enough to equip their aircraft with appropriate navigational equipment should enjoy the benefits of their investments. For those more frugal operators, it would be possible to establish different, and likely more circuitous routes.

4.4 WEATHER

Surface weather observations, including current altimeter settings, are required for instrument approaches. While surface weather observations are available at large FAA facilities most of the time and at smaller, part-time (day/evening) FAA facilities some of the time, remote operating locations generally do not possess this capability. This will generate a need for weather observations at remote and/or unmanned sites. Installation of an automated weather observing system (AWOS/ASOS) would fill this potential gap.

4.5 FACILITY CONTROL POSITIONS

The number of control positions required in the ARTCC will probably not be affected since they control relatively few IFR helicopters. In the event that there should be a significant increase in IFR helicopter operations the increase would probably be more noticeable in TEC or in a system similar to the existing Northeast Corridor, both of which have been established in approach control airspace. This could eventually lead to a requirement to establish additional operating positions at TRACON's to handle tower enroute traffic during busy periods or at those facilities that control numerous IFR helicopters.

4.6 SUMMARY

Discussions with both helicopter operators and air traffic controllers failed to uncover any significant restraints that preclude helicopters from proceeding virtually unrestricted during the en route phase of flight. However, since many helicopter operations are performed at very low operating altitudes and from off-airport locations, such as heliports, they often generate requirements for ATC services in areas not normally flown by fixed-wing aircraft.

4.6.1 Communications

Communications requirements are currently being met by VHF. If, as anticipated, IFR helicopter operations grow significantly, frequency congestion will very likely become a problem. Satellite communications may offer a solution although there are questions regarding the suitability of satellite communications for small aircraft.

4.6.2 Navigation

In the VFR environment, and IFR offshore, helicopter enroute navigation requirements are being met by LORAN-C. LORAN-C also offers the possibility of providing a nonprecision approach capability. When GPS is approved and available to general aviation, it could also provide these necessary services to rotorcraft.

4.6.3 Surveillance

The use of LOFF techniques hold promise for helicopters during both offshore and remote area operations, while the possibility of a satellite-based ADS capability is questionable for small and medium size helicopters at the present time. LOFF system integrity and the availability of communications channels continue to pose questions that need to be answered.

4.6.4 Weather Services

Any expanded IFR helicopter operations from off-airport sites such as heliports and/or vertiports will require current weather observations for these locations. The lack of qualified weather observers may generate a requirement for additional automated weather observing systems (AWOS/ASOS).

4.6.5 Air Traffic Control Operating Positions

The potential growth of IFR helicopter operations probably will not impact ARTCC operations and their staffing should not be affected. However, any significant increase in TEC operations would affect the TRACON's operations and could require the establishment of additional operating positions during busy traffic periods.

5.0 RECOMMENDATIONS

Based on the analysis of current procedures, a review of current air traffic control standards, and discussions with both users and providers of NAS services, the following recommendations are tendered.

5.1 LOW ALTITUDE ATC OPERATING SYSTEMS

By all accounts, the concept of integrated fixed-wing and rotorcraft traffic in the low-altitude IFR route structure through tower enroute control has proven to be far more successful than separate route structures, as provided by the Northeast Corridor program.

It is recommended that future rotorcraft low-altitude IFR route structures be developed using tower enroute control as a basis unless there are compelling reasons to develop separate route structures.

5.1.1 Tower En Route Control

TEC appears to have met or even exceeded its original goal; consequently, the only recommendation would be to explore the possibility of expanding into areas where TEC does not currently exist and to provide routes that connect heliports and vertiports to the TEC network.

5.1.2 Northeast Corridor

The Northeast Corridor needs a major overhaul if it is to become a useful, viable addition to the NAS. If the concept can be fully developed, similar systems could be designed for other high density traffic areas that could assist in relieving congestion.

Recommendations:

(1) Relocate and redesign the Northeast Corridor to better serve the airports/heliports that it was originally intended to serve.

(2) Designate LORAN-C as the primary IFR navigational aid. If feasible, utilize the VOR/DME system as an emergency backup.

(3) Reduce the number of waypoints that are required to navigate routes within the Corridor.

(4) Develop IFR flight tracks that approximate standard VFR tracks, and use direct routes where appropriate.

(5) Provide transition routes to and from the primary airports and heliports along the routes that permit efficient ingress/egress with a minimum of pilot/controller interaction, i.e PDAR's, STAR's, and standard instrument departures (SID) should be developed to connect the Corridor with airports/heliports and vice versa.

(6) Provide en route altitudes that are consistent from sector to sector or between facilities to preclude altitude changes immediately before and/or after transfer of control between facilities.

(7) Simplify Corridor procedures to permit public use. If necessary, consider widening the airway beyond its current 4 mile width.

(8) Where feasible, develop routes that do not interfere with existing Victor airways. Since this is not always possible, attempt to cross the Corridor routes and the conventional airways at angles as close to 90 degrees as possible and in areas of least congestion.

(9) Altitudes should be within radar coverage to be consistent with the basic requirements of the TEC program.

(10) If the majority of these improvements are not possible, the Northeast Corridor project and AC 73-2 should be cancelled.

5.2 ATC SUPPORT REQUIREMENTS FOR ROTORCRAFT

5.2.1 LORAN-C Offshore Flight Following

The LOFF program appears to offer the greatest potential for a relatively inexpensive surveillance system in overwater areas that are beyond and/or below radar coverage. Even though it may not be possible to provide separation standards that equate to radar separation, the use of LOFF could certainly reduce separation minima from the nonradar standards that are in use today.

Recommendations:

(1) Expedite evaluation of the latest LOFF simulation and test program.

(2) Develop separation standards, based on the results of this evaluation, that will permit operational use of the system.

(3) Develop air traffic procedures for use by controllers to ensure that these standards are maintained.

(4) Develop procedures to enable pilots to depart and subsequently return to the LOFF system for the purpose of conducting approaches and departures to/from heliports not located on a published route.

(5) Institute a study to determine the feasibility of expanding the LOFF system to include areas throughout the NAS that are not within coverage of existing radar systems.

(6) Evaluate the potential for use of GPS in an ADS system, both as a substitute for LORAN-C, and in addition to LORAN-C.

(7) Evaluate ADS/LOFF in terms of system integrity. Consider failure of communications and navigation elements of the system and determine the impact on ATC. Also consider the use of backup/alternative navigation sensors and communications channels.

5.2.2 Weather Services

Weather services for helicopters are lacking at most heliports and services are provided from nearby airports. During the late evening and night hours the problem grows more acute in areas where weather services are provided by part-time ATC facilities that close at night. It is recommended that an evaluation of weather services for rotorcraft be conducted to identify current and potential shortfalls.

6.0 CONCLUSIONS

IFR helicopter operations are in their infancy and will likely mature over the next 2 decades. Unique air traffic control procedures must be adopted to ultimately provide rotorcraft with independent but equal access to terminal airspace, airports, and/or heliports.

In the en route segment of flight, helicopters are confronted with very few restrictions when they operate in a radar environment. Outside of a radar environment, conditions deteriorate and numerous delays are encountered.

6.1 ATC ROUTE STRUCTURES

6.1.1 Tower En Route Control

The TEC program, integrating slower speed fixed-wing aircraft and helicopters in low-altitude airspace works well in many areas of the country. Use should be considered in other areas where traffic levels warrant route structure development.

Expansion of the program to incorporate transition routes to/from airports/heliports, and routing to provide access to helicopter instrument approach and departure paths will provide better service than developing or redesigning separate helicopter route structures similar to the Northeast Corridor.

6.1.2 Northeast Corridor

The Northeast Corridor Program, while perhaps valid in concept, was flawed in its implementation in many ways. These include:

(1) Lack of radar coverage on several segments of the route at the allocated altitudes,

(2) no public-use instrument approaches exist to heliports served by the Corridor,

(3) no transition routes exists between the Corridor and conventional instrument approaches to the airports,

(4) An excessive number of waypoints that tend to increase pilot workload and make the routes difficult to fly,

(6) The lack of provisions for instrument approaches, missed approaches, and departure procedures,

(7) Establishment of route widths using TERPS methodology that was designed for obstruction avoidance, not aircraft separation.

(8) Route evaluations that were flown with the RNAV systems operating in the terminal or approach modes without instructions for pilots to operate in this mode during normal operation, and,

(9) The lack of a description of pilotage techniques and/or specialized training requirements necessary to remain within the reduced airspace.

Any further consideration of separate helicopter routes must fix these flaws.

6.1.3 Point-in-Space Procedures

Point-in-space approach procedures, as implemented in Northeast Corridor program, are flawed. Flaws include:

(1) The point-in-space approaches are merely that, approaches to points, beyond which pilots are on their own.

(2) Briefings indicate that the point-in-space approach would lead to a point from which the helicopter pilot "cancels IFR and proceeds VFR to the destination." This position has not proven to be legally supportable, as the pilot cannot be required by the procedure to cancel IFR.

(3) Most approaches indicate course and distance to the point of intended landing; however, the indicated courses cannot be flown consistently because of numerous airspace conflictions.

(4) Helicopters using overwater approaches could

(a) be restricted from carrying passengers,

(b) be required to be multi-engine with single-engine climb capability, and/or

(c) be required to carry flotation devices.

(5) Approaches which terminate over water, often several miles from land, are neither restricted to increased visibility requirements nor denied night time operations as required by the visual and/or surface light reference requirements of 14 CFR 135.207.

6.2 ATC SUPPORT SYSTEMS

6.2.1 Communications

At the present time, VHF communications services are adequate at most locations. As helicopter operations grow and expand coverage and frequency congestion problems may become more acute.

6.2.2 Navigation

LORAN-C provides acceptable navigation in areas of adequate coverage and is being expanded into the mid-continent areas of the country. GPS will likely provide additional navigation services in the mid to late 1990's. The most pressing navigation related needs are helicopter instrument approaches to airports and heliports.

6.2.3 Dependent Surveillance

The LORAN-C flight following concepts developed in the Gulf of Mexico appear to represent the most cost-effective means of extending ATC surveillance to helicopters in areas not currently operating within radar coverage, both overwater and land. Dependent Surveillance systems can employ LORAN-C, GPS, and multi-sensor RNAV systems for position determination. In the near term, VHF communications appears to be the most viable data link. Satellite data links may prove to be more practical in the long term.

6.2.4 Weather Services

Weather services, particularly local observations, are not adequate at night and in remote areas where helicopters operate. Additional weather observing systems (AWOS/ASOS) at strategic locations could potentially fill some of this need.

6.2.5 ATC Operating Positions

Because helicopters operate at low altitudes, there is no need for additional ATC operating positions at ARTCC facilities. In areas of high helicopter activity, additional control positions may be required at TRACON's during busy hours.

LIST OF REFERENCES

1. "Analysis of NDB Frequency Congestion Alleviation", Bolz, Eric H., McKinley, John B., Systems Control Technology, Inc., November 1982.

2. Census of U.S. Civil Aircraft, 1988.

3. "Microwave Landing Systems for Heliport Operators, Owners, and Users", Kristen J. Venezia, Edwin D. McConkey, Systems Control Technology, Inc., June 1985.

4. Aeronautical Satellite News, September 1989.

5. Airman's Information Manual (AIM)

6. Title 14, Code of Federal Regulations - Parts 60 through 139

7. Rotorcraft Master Plan (RMP) - November 1990

8. Capital Investment Plan (CIP) - December 1990

FEDERAL AVIATION ADMINISTRATION DOCUMENTS

Handbook/Order	Title
7030.1A	Protected Airspace for Instrument Approach Procedures
7100.8A	Standard Instrument Departure (SID)
7100.9A	Standard Terminal Arrival (STAR)
7110.10I	Flight Services
7110.65F	Air Traffic Control
7110.83B	Oceanic Air Traffic Control
7110.91	Tower En Route Control
7110.102	Air Traffic LORAN-C Approach Procedures
7210.3I	Facility Operations and Administration
7210.47A	Traffic Management System
7400.2C	Procedures for Handling Airspace Matters
7610.4G	Special Military Operations
8260.3B	United States Standard for Terminal Instrument Procedures (TERPS)
8260.19A	Flight Procedures and Airspace

Advisory Circular	Title
AC 20-130	Airworthiness Approval of Multi-sensor Navigation Systems for Use in the U.S. National Airspace System (NAS) and Alaska
AC 61-13B	Basic Helicopter Handbook
AC 70/7460-2H	Proposed Construction or Alteration of Objects that May Affect the Navigable Airspace
AC 73-2	IFR Helicopter Operations in the Northeast Corridor

Advisory Circular	Title
AC 90-5	Coordination of Air Traffic Control Procedures and Criteria
AC 90-45A	Approval of Area Navigation Systems for Use in the U.S. National Airspace System
AC 90-76A	Flight Operations in Oceanic Airspace
AC 90-80A	Approval of Offshore Helicopter Approaches
AC 90-82	Random Area Navigation Routes
AC 90-83	Terminal Control Areas (TCA)
AC 210-5A	Military Flying Activities

LIST OF ACRONYMS

AC................Advisory Circular
ADF...............Automatic Direction Finder
ADS...............Automatic Dependent Surveillance
AGL...............Above Ground Level
AIM...............Airman's Information Manual
ARA...............Airborne Radar Approach
ARSA..............Airport Radar Service Area
ARSR..............Air Route Surveillance Radar
ARTCC.............Air Route Traffic Control Center
ATA...............Airport Traffic Area
ATC...............Air Traffic Control
ATCT..............Airport Traffic Control Tower
AWOS/ASOS.........Automated Weather Observing System/Automated Surface Observing System
CFCF..............Central Flow Control Facility
CIP...............Capital Investment Plan
CFR...............Code of Federal Regulations
CNS...............Communications, Navigation, and Surveillance
CTAF..............Common Traffic Advisory Frequency
DME...............Distance Measuring Equipment
EARTS.............En Route Automated Radar Tracking System
ERHC..............Eastern Region Helicopter Council
FAA...............Federal Aviation Administration
FTE...............Flight Technical Error
GPS...............Global Positioning System
HAA...............Helicopter Association of America
HAI...............Helicopter Association International
ICAO..............International Civil Aviation Organization
IFR...............Instrument Flight Rules
ILS...............Instrument Landing System
IMC...............Instrument Meteorological Conditions
LOFF..............LORAN-C Offshore Flight Following
LORAN-C...........Long Range Navigation
MAP...............Missed Approach Point
MDA...............Minimum Descent Altitude
MEA...............Minimum En Route Altitude
MLS...............Microwave Landing System
MSL...............Mean Sea Level
NAR...............National Airspace Review
NAS...............National Airspace System
NAVAID............Navigational Aid
NDB...............Nondirectional Beacon
NM................Nautical Mile
OSAP..............Offshore Standard Approach Procedure
PDAR..............Preferential Arrival/Departure Route
R&D...............Research and Development
RCAG..............Remote Communications Air/Ground Facility
RCF...............Remote Communications Facility
RMP...............Rotorcraft Master Plan
RNAV..............Area Navigation

SID...............Standard Instrument Departure
STAR..............Standard Terminal Arrival
SVFR..............Special Visual Flight Rules
TACAN.............Tactical Air Navigation Aid
TCA...............Terminal Control Area
TEC...............Tower En Route Control
TERPS.............Terminal Instrument Procedures
TRACON............Terminal Radar Approach Control Facility
UHF...............Ultra High Frequency
VFR...............Visual Flight Rules
VHF...............Very High Frequency
VMC...............Visual Meteorological Conditions
VOR...............Very High Frequency Omni-directional Range
VOR/DME...........VOR and DME (collocated)
VORTAC............VOR and TACAN (collocated)
VTOL..............Vertical Takeoff and Landing